My View

by Hugh Ching

Fuzzy Logic

The Genius of Lotfi Zadeh

Lotfi Askar Zadeh was the father of fuzzy logic, and, according to many, he was mankind's most renowned thinker. The greatness of Zadeh can be realized from the ubiquitous effect of fuzzy logic on all knowledge that, henceforth, a solution should be defined as all the answers, which lie within the fuzzy range of value or tolerance of the solution. Fuzzy logic, a postcreational technology, has helped propel human knowledge forward thousands of years, far beyond scientific and postscientific applications.

Understanding Fuzzy Logic

The key to fully understanding fuzzy logic involves answering two important questions: 1) Why is reality fuzzy? and 2) When is fuzzy logic necessary?

Reality is fuzzy because precision is sacrificed during the process of expanding a creation's range of tolerance. Whether that creation is a human being or a washing machine, for it to survive and flourish in a permanently uncertain future, fuzzy logic becomes necessary and essential when the creator is absent.

While engineering deals with the construction of temporary entities, life science pertains to the establishment of permanent entities. From a postscience or universe-centered point of view, engineering should not be considered as life science because any temporary creation will sooner or later become valueless. When an engineering product, e.g., a driverless car, encounters an unforeseen issue, its human creator, or the driver, can still intervene to manually correct the problem. However, the human being or the entire living system must be able to survive in the absence of its creators. All of the possibilities of the future must be considered in the design of the living system. Furthermore, the future must not be left to chance or probability—since probability deals with certainty—because a probabilistically designed living system will eventually perish.

From a technical point of view, the range of tolerance of the living system must be wide enough to cover all of the possibilities of a permanently uncertain future. This range of tolerance or expansion in synthesizing emotion or distorting reality could be considered the ultimate psychological defensive mechanism against failures. For example, emotional quotient (EQ) is a measure of the range of tolerance of others' mistakes. Survival is more important than precision; therefore, precision is sacrificed during the process of expanding the range of tolerance of a creation. As a result, fuzzy logic is considered a postcreational technology, while postscience, a creational technology and science, a nonliving technology. Engineers currently working on fuzzy logic have successfully tested the concept of the range of value or tolerance on temporary or nonliving products, and their findings indicate that only when the originator is no longer available is fuzzy logic necessary.

The previously described questions and answers, and their implications, are what separates Zadeh and his devotees from the rest of the world as well as from the fuzzy logic community. For scientists who have developed the practice of and are accustomed to being exact, fuzzy logic can be difficult to understand. To fully appreciate fuzzy logic, postscience, which deals with the solutions of value, complete automation, and robot touch, all of which involve fuzzy logic, must first be understood.

The Concept of Fuzzy Logic

Fuzzy logic is best summarized in one short sentence: Fuzzy is more accurate than exact. Fuzzy logic has raised the ceiling on mathematics by replacing the mathematical concept of exact solution with "fuzzy exact solution," as the most accurate description of reality. In logic, fuzzy logic offers an operational definition of computer science that states, "computer science is the communication between the fuzzy human and the exact computer." In life science, the exact deoxyribonucleic acid (DNA) generates a living system that has sacrificed precision as the range of tolerance of that living system is expanded for it to survive and flourish, given all of the possibilities in a permanently uncertain future. Even though recognition should be given to all of the visionary thinkers contributing to the pioneering evidence that fuzzy logic is useful in engineering, the full significance of fuzzy logic will only be revealed when applied directly to the living system, which is far beyond the current domain of engineering and science.

With the passing of Zadeh on 6 September 2017, fuzzy logic will enter into a new era. Applications from engineering based on science will advance into applications in life science based on cognitive science, artificial intelligence (AI), synthetic biology, and postscience, whose solutions of value, complete automation, and robot touch is naturally fuzzy (not exact), while solutions in the

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current age of science are exact. Zadeh, therefore, has established a solid technical foundation for describing the fuzzy reality with his founding of fuzzy logic, specifically in the areas of range of value or tolerance, possibility theory, and the general theory of uncertainty, all of which form a completely logical system that explains why reality is fuzzy. Unfortunately, fuzzy logic will become necessary only after we are all dead. Additionally, Zadeh spearheaded the invention, the explanation, or the foundation of the following ideas and theories:

- *Z*-transformation
- common sense
- decision theory
- free will
- computing with words
- *Z*-number
- membership functions
- the restriction-centered theory of truth and meaning
- fuzzy sets
- fuzzy numbers
- fuzzy mathematics
- soft science.

Fuzzy information science, the last project he worked on before his passing, will likely be at the forefront of technology in the years to come.

The most convincing argument for creationism, as opposed to random evolution, are the discoveries of postscience and fuzzy logic. In particular, postscience has identified DNA as a completely automated software; therefore, the living system can be manufactured when DNA is programmed using just the computer source code 0, 1, 2, and 3. Postscience demonstrates the feasibility of mankind's self-formation, which, in turn, demonstrates that mankind is self-created. The fact that reality is fuzzy rather than exact provides one of the most convincing arguments in support of creationism. Universal permanent software (UPS) can be considered a theoretical discovery of DNA by identifying DNA as self-generating software, which should be considered even more significant than the 1869 discovery of DNA's existence, as well as the 1953 experimental discovery of DNA's structure, because the theoretical UPS connects mankind to its creators and to the universal community [1]. The theoretical discovery of DNA leads to a change in the representation of DNA nucleotides, from *A*, *C*, *G*, and *T* (which have no operational significance) to 0, 1, 2, and 3, to allow a parity check of 3s and other logic operations. DNA is quaternary versus binary for the computer, as illustrated in Table 1.

TABLE 1 – THE THREE DIGITS OF QUATERNARY DNA AND BINARY COMPUTATIONAL REPRESENTATIONS.

QUATERNARY (DECIMAL)			DNA	BINARY (DECIMAL)		
THIRD DIGIT	SECOND DIGIT	FIRST DIGIT		THIRD DIGIT	SECOND DIGIT	FIRST DIGIT
3 (=48)	3 (=12)	3 (=3)	T			
2 (=32)	2 (=8)	2 (=2)	G			
1 (=16=4^2)	1 (=4=4^1)	1 (=1=4°)	C	1 (= 4=2^2)	1 (=2=2^1)	1 (=1=2°)
0 (=0)	0 (=0)	0 (=0)	A	0 (=0)	0 (=0)	0 (=0)

Computer science manages the interaction between the fuzzy human and the exact computer, and computer software automates knowledge. Concurrently, the UPS completely automates software. It starts with a universal user interface (UUI) that is arranged in a simple tree-structured, numerical multiple-choice question format. In the case of DNA, the UUI can be written for all three levels as: 1) adenine (*A*), 2) cytosine (*C*), 3) guanine (*G*), and 4) thymine (*T*). The integers 1, 2, 3, and 4 are to be the answers to the questions and will form the integer source code to be handled by the computer. For example, choosing 1, 1, and 1 for the three levels will lead to the codon 111 or AAA = lysine. The human language expressions adenine (*A*), cytosine (*C*), guanine (*G*), and thymine (*T*) are to be read by humans, and they can be changed into, say, Chinese to form a UUI for the Chinese, such as: 1) 腺嘌呤 (*A*), 2) 胞嘧啶 (*C*), 3) 鸟嘌呤 (*G*), and 4) 胸腺嘧啶 (*T*). Or, the order of the integer choices can be altered to form a new UUI, such as: 1) thymine (*T*) 2) cytosine (*C*), 3) guanine (*G*), and 4) adenine (*A*). The UPS patent [1] has shown that the UPS can automatically update the old source code 111 to the new source code 444, as has been demonstrated in the virtual machine. In this case, the UPS can be considered a novel use of an old idea, i.e., the virtual machine. The novelty is complete, rather than partial, automation.

DNA is a chemical generator that generates protein by feeding RNA into the ribosome; in fact, DNA is so powerful that it makes its host modify the function of DNA according to the behavior of the host (i.e., according to its lifestyle). Postscience believes that DNA, with its inherent wisdom, dominates the universe, while 0, 1, 2, and 3 correspond to computer source codes in computer science. The source codes are used to generate the program, which corresponds to protein.

The user interface of any programming language can be manually converted into a UUI, and the UUI can be automatically updated to completely sync with any other UUI. Furthermore, using the self-generating feature of UPS [1], the UUI can be converted to any native human language or any multimedia expression. Thus, the greatest practical contribution of the UPS to the progress of human knowledge is the possibility of all humans over the age of six, and even some intelligent animals, to be able to write software, which will not become obsolete as the programming language changes.

The UUI mathematically corresponds with the set theory, which allows similar items to be grouped into subsets in the second and lower levels of the UUI and physically and cognitively corresponds with the fuzzy human associative memory (HAM), which allows humans to access an unlimited amount of information even though it is fuzzy. The native human language in the UUI is permanently fuzzy but isolated

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can now incorporate some millions of transistors. With these credentials, the transistor has conquered areas that traditionally pertained to other technologies. It is often easier and cheaper to use a microcontroller (a type of IC) and implement into it a program for executing a control function than to perform the same operation with a mechanical controller. Few devices have had such a profound influence on industrial production and social life.

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the execution of the computer. The executable source code or the choices in the UUI are completely flexible or interchangeable in the UPS. An obvious choice of a UUI corresponding directly to Table 1 can be written for all three levels of UUI as 0) adenine (A), 1) cytosine (C), 2) guanine (G), and 3) thymine (T). And lysine (AAA) can be represented by the integer 0. DNA source code in the form of 0, 1, 2, and 3 can be directly fed into the UPS to generate the representations of the 64 codons or any protein.

A demonstration is available to show that the UPS can self-generate to form a neural network of software cells that can increase to an unlimited size or until the disk is full. The self-generated network can eventually be developed into an electronic brain, with features such as HAM. Thus, in the design of a self-generating, completely automated intelligent system with unlimited complexity, such as the living system and a completely automated computer system, HAM is needed to create HAM. Even today, the usefulness of HAM, possibly without being fully recognized by current computer designers, has been amply demonstrated by the computerized hypertext system, the computerized menu system, and the computerized library system, all of which enable their users to theoretically access an unlimited amount of information but have not yet incorporated the completely automated capability of the UPS [1].

Conclusions

Mankind owes a debt of gratitude to Lotfi Askar Zadeh and his dedicated team of researchers for their pioneering research in the field of fuzzy logic. Their relentless pursuit has opened the eyes of the world to this revolutionary technology. My friend and colleague lived a rational but very lonely intellectual life, having few colleagues who understood and could discuss the depths of his thinking. I am grateful that, after ten years of interaction with him, I finally understand his visionary concept of fuzzy logic.

Biography

Hugh Ching (post.science@yahoo.com) received his B.S., M.S., and Sc.D. degrees from the Massachusetts Institute of Technology, Cambridge. He is the founder of the Knowledge-Oriented Society and the father of postscience. His mentors include some of the greatest thinkers of our time. Harold Grad, an intellectual descendant of David Hilbert, mentored him in mathematics, and Paul Feyerabend mentored him in philosophy relating to postmodern science. Additionally, Milton Friedman mentored him in economics relating to deregulating man-made laws. Chitoor V. Ramamoorthy mentored him in software engineering. Ta-You Wu, the father of Chinese physics, was advised by his close collaborator, Tosiyasu L. Kunii, founder of the Department of Information Science at the University of Tokyo, to collaborate with him. Wu took this advice, and they worked together, particularly on the solution of robot touch based on their newly discovered physics concept of jumpulse, a sudden change of force, as Newton's impulse is a sudden change of momentum. He solved the problem of value posed by his friends Kenneth Arrow and Gerard Debreu. Lotfi A. Zadeh, the father of fuzzy logic, guided him to realize that "fuzzy is more accurate than exact."

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